BEARS: Radioactive Ion Beams at LBNL

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There is currently strong world-wide activity in the development and construction of radioactive ion-beam facilities of various types. The availability of beams of unstable nuclei offers exciting new opportunities for research into nuclear structure and nuclear astrophysics. BEARS, or Berkeley Experiments with Accelerated Radioactive Species, is an initiative to develop a radioactive ion-beam capability at the 88" cyclotron.

The initial BEARS system will involve the production of light-mass proton-rich species in Bldg. 56 using the 10 MeV proton beam of the LBNL Medical Cyclotron, the resulting radioactivities being continuously transported to Bldg. 88 via a gas-jet capillary. Here, the carrier gas will be skimmed away and the isotopes will be injected into the 88" cyclotron's ECR ion source, allowing the ionization and acceleration of high-quality radioactive beams.

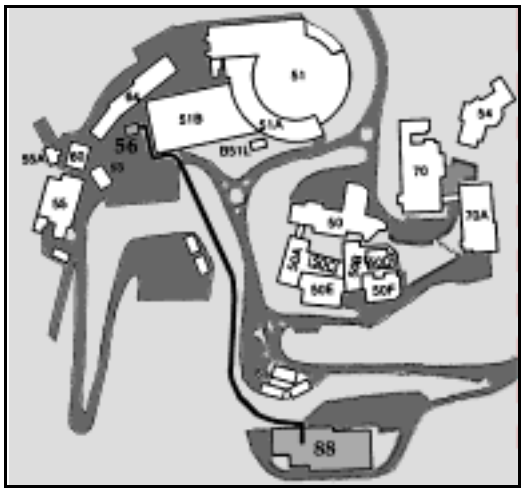

Fig. 1. Map showing proposed transfer line between Bldgs. 56 and 88.

The first radioactive beams to be developed will include 20-min ^{11}C, 10-min ^{13}N, and 70-sec ^{14}O, produced by (p,n) and (p,α) reactions on low-Z targets. The first series of experiments will likely include some of the following, each of which is characterized by relatively large cross sections and modest experimental requirements:

- Elastic scattering of mirror nuclei, e.g. ^{11}C - ^{11}B, ^{13}N - ^{13}C, or ^{14}O - ^{14}C
- Single and mutual excitation in inelastic scattering
- Sub-barrier fusion and transfer reactions with weakly bound projectiles
- Measurement and systematics of fusion/evaporation excitation functions with radioactive projectiles

A novel approach of BEARS is the coupling of the technique of gas-jet transport to the use of the ECR for ionization and extraction of radioactive species. This approach is one which avoids many of the well known difficulties of the integrated target/ion source method (e.g. complicated chemical speciation problems and large decay losses in ion-source hold-up times).

As the initial BEARS system utilizes pre-existing cyclotrons and other capital equipment, it can be developed on a rapid time scale with only a moderate financial outlay. The only major new technology required, the previously untried coupling of a gas-jet transport system to an ECR ion source, is currently being developed in a test program at the 88" cyclotron (see next report). However, BEARS as described is limited both by the capabilities of the Medical cyclotron and by the 70 sec transit time resulting from the distance between Bldgs. 56 and 88. A possible future development would be the installation of a high-intensity, 30 MeV cyclotron at Bldg. 88, allowing a wider range of higher-intensity radioactive ion beams with shorter half-lives. In any case, investigation of the BEARS approach is very relevant as an option for implementation at a future large national radioactive beam facility, such as the Isospin Laboratory, that has been identified as the highest priority for major new construction by DOE [1].

Footnotes and References

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1. 1996 DOE/NSAC Long Range Plan for Nuclear Physics